ARGON AND HELIUM IN METEORIC IRON.

IN the light of the new discoveries of argon and helium, it appeared that the reinvestigation of the gas evolved on heating meteoric iron might promise interesting results. This anticipation has been fulfilled. Meteoric iron, heated *in vacuo*, yields a small amount of both argon and helium, besides a comparatively large quantity of hydrogen.

The investigation of gases occluded in meteoric iron was undertaken by Graham in 1867 (*Proc. R. S.*, xv. 502). From 45·2 grams of a specimen of iron from Lenarto, in Hungary, Graham obtained, by heating it *in vacuo*, 16·53 c.c. of gas, consisting of 85·68 per cent. of hydrogen, 4·46 of carbonic oxide, and 9·86 per cent. of "nitrogen." And eight years later, Prof. Mallet investigated the gases from a specimen of meteoric iron from Augusta County, Virginia, and found 35·83 per cent. of hydrogen, 38·33 per cent. of carbonic oxide, 9·75 per cent. of carbonic anhydride, and 16·09 per cent. of "nitrogen." (*Proc. R. S.*, xx. 365.)

In the same year, Prof. A. W. Wright examined spectroscopically the gases evolved from two meteorites, one the "great Texas meteorite" in the museum of Yale College, which weighs 742 kilograms; another a specimen of meteoric iron from Tazewell County, Tennessee; and a third set of experiments was made with fragments of a meteorite from Arva, in Hungary. The gases obtained were examined spectroscopically, and were found to show the usual spectra of hydrogen, carbon compounds, oxygen, and nitrogen. He was searching for lines present in the spectra of stars, but found none; and he concludes that the spectrum of the solar corona is to be ascribed merely to atmospheric gases. A preliminary account of the examination of a fourth (a stony) meteorite is given in the same journal (*Amer. Journal of Science* [3], ix. pp. 294 and 459), and the full account in vol. x. 44. Suffice it to say that the last fractions of gas evolved contained 6·91 per cent. of "nitrogen." On p. 257 of the next volume (xi.), Prof. Wright gives analyses of the gases from various samples of meteorites, which contain from 1·54 to 5·38 per cent. of "nitrogen." And lastly, in vol. xii. p. 165, he gives further details, including descriptions of spectra, in none of which he noticed anything unusual.

Prof. Wright's interesting papers are instructive, inasmuch as they show how little reliance is to be placed on the evidence of the spectroscope as to the presence of any one gas in a gaseous mixture consisting of a large proportion of other gases. There is no doubt that in future, much attention should be paid to the relative conductivity of gases. The characteristic spectrum of argon is almost completely masked by the presence of a few parts per cent. of nitrogen or of hydrogen; and that of helium is similarly affected, although to a less degree. Though no quantitative experiments have been made on the subject, yet I should judge that the presence of from 5 to 10 per cent. of nitrogen entirely obscures the characteristic yellow line; the other strong lines still remain visible. I hope soon to be able to communicate further information on this interesting subject.

The presence of both argon and helium has been demonstrated in the meteorite from Augusta County, Virginia, a sample of which was purchased from Mr. Gregory. Two ounces of turnings of this meteorite were heated to bright redness in a hard glass tube, all air having been first removed in the cold by a Töpler's pump. From this iron, 45 c.c. of gas were obtained. It was mixed with oxygen in a gas burette, and exploded. It appeared to consist for the most part of hydrogen. After absorption of any carbon dioxide and the excess of oxygen with alkaline pyrogallate, the residue amounted to about half a cubic centimetre. It was transferred to a small tube and dried with a morsel of solid caustic potash, and with it several vacuum tubes were filled. The spectrum showed that it consisted for the most part of argon; the trace of nitrogen which appeared at first rapidly disappeared under the influence of the discharge.

The spectrum was carefully compared with that given by a tube of atmospheric argon, provided with magnesium electrodes. This sample of argon always shows the D lines of sodium, owing to the magnesium electrodes, and proves especially convenient for the detection of helium, the yellow line of which is not coincident with the lines of sodium. Both spectra were thrown into a two-prism spectroscope at the same time, and on careful comparison it was evident that all the argon lines were present. Besides these, the yellow line D_3 of helium was faintly visible, not coincident with the sodium lines; and on comparing the spectrum of the gas directly with that of helium from cleveite, it was possible to recognise the identity of the red, blue-green, blue, and violet lines of helium in the meteoric gas. No other lines were visible than those of argon and helium. It may thus be concluded, on spectroscopic evidence, that both argon and helium are contained in meteoric iron, the former in much larger amount than the latter. This conclusion was verified by mixing about 90 per cent. of argon with 10 per cent. of helium. The spectrum of helium, under these circumstances, was much more brilliant than that of argon; hence it may be concluded that less than 10 per cent. of this gaseous residue consisted of helium.

It appeared likely that metallic iron might be induced to absorb argon. It had been noticed, last October, that in attempting to prepare argon by passing atmospheric nitrogen through iron tubes filled with magnesium turnings, and heated to redness, a smaller quantity of argon than usual was collected. This rendered it not improbable that iron at a red heat is permeable to argon. If permeable, then it might be permanently absorbed. An experiment was therefore undertaken by Mr. Kellas, to whom I have to express my indebtedness, to ascertain whether finely divided iron, obtained by the reduction of ferric oxide in hydrogen, would occlude argon.

About 14 grams of the finely divided iron was placed in a combustion-tube, the capacity of which was 53·6 c.c. The tube was connected by a three-way stopcock to a Sprengel's pump and to a water-jacketed reservoir containing argon over mercury. After exhausting the tube, argon was allowed to enter, and the temperature was slowly raised to 600° and maintained for three hours. Until equilibrium of temperature had been established, no perceptible change of volume could be noted. The tube was allowed to cool, connection with the argon reservoir was closed, and the gas was pumped off. The volume, corrected for temperature and pressure, was 54·2 c.c. On heating the tube, about 59 c.c. of gas was given off; it was collected in three fractions, (*a*), (*b*), and (*c*), the heating having been continued for twelve hours.

(*a*) The volume of this gas was 30 c.c. It was collected at about 200° C. This was exploded with oxygen; and a residue was obtained, of which the greater part dissolved in caustic potash, showing that the gas had consisted of hydrogen and hydrocarbons. The final residue was 1·7 c.c.

(*b*) The second fraction, collected at 450°, amounted to 15 c.c., and after treatment as above, the residue was 0·25 c.c. This residue was united with that from (*a*), and a vacuum tube was filled. The flutings of carbon were visible, and also a trace of hydrogen, but no argon. This gas was sparked with 1 c.c. of oxygen, and on absorbing the excess of oxygen with alkaline pyrogallate, 0·45 c.c. remained. On transferring this residue to a vacuum tube, the banded spectrum of nitrogen was alone visible.

(*c*) The third fraction, collected at a red heat, also showed only the spectrum of nitrogen, when purified and transferred to a vacuum tube, and on continuing the discharge it also disappeared and the tube became

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phosphorescent. Judging from previous experience, the presence of argon would have revealed itself after the nitrogen had disappeared. It may therefore be concluded that whether iron is permeable to argon at a red heat or not, it does not permanently retain the gas. It is not improbable that the condition of retention may be that the iron is heated to fusion in an atmosphere of hydrogen, hydrocarbons, argon, and helium, and that it is then suddenly cooled. This I should imagine to be the case if the iron were ejected from some stellar body at a high temperature. I am, however, unaware whether any of the lines of the argon spectrum have been identified in the spectra of stars; if not, it is probably because they are masked by the spectra of hydrogen and carbon.

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SUBTERRANEAN FAUNAS.

THE researches of geologists and engineers have revealed the existence of vast tracts of underground waters, often associated with more or less extensive caves. The investigation of these underground waters is interesting to naturalists, as it has led to the discovery of a special subterranean fauna, different in different regions, it is true, but characterised throughout by modifications in certain definite directions. The study of these modifications is a fascinating one, and the problem of their evolution seems to be rendered comparatively easy by the simplicity and limitations of the conditions of life which obtain beneath the earth's surface; for these subterranean forms live in continual darkness, and are exposed to a fairly uniform temperature at all times. It is also, in many cases, possible to tell from what surface-species an underground form has descended, and to infer the age of the latter with a fair approach to accuracy; the nature of the changes undergone, and the rate at which these modifications have taken place, can thus be estimated in particular instances.

It will be remembered that in Packard's well-known memoir on the Cave Fauna of America, the peculiar modifications of subterranean animals were interpreted as lending strong support to the theory of the inheritance of acquired characters. Recently, however, in a careful and interesting memoir on the subterranean Crustacea of New Zealand (*Trans. Linn. Soc.*, London, vol. vi., 1894), Dr. Chilton considers the question from the Neo-Darwinian aspect; and he adduces a number of facts and arguments which greatly tend to reduce the force of Packard's contentions.

Dr. Chilton begins his memoir with a completed account of the New Zealand subterranean Crustacea, including a description of some new species. The underground crustacean fauna of New Zealand has a more varied aspect than that of Europe or North America; of the six species known, three are Amphipods and three Isopods, and these belong to as many as five different genera. Among them *Gammarus fragilis* is interesting to us as being allied to the blind *Niphargus* of Europe. *Cruregens fontanus*, an Isopod belonging to the family Anthuridæ, is curious in possessing only six pairs of legs; the seventh segment is small and without appendages, as is the case also in young Isopods; this larval character is retained in *Cruregens*, probably owing to an arrest in development on account of the scanty supply of food. Two subterranean species of the genus *Phreatoicus* are described, *P. typicus* and *P. assimilis*, n. sp.; a surface species, *P. australis*, lives on the top of Mount Kosciusko in Australia. This genus is peculiar, and the type of a new family of Isopods which approaches the Asellidæ in some respects, but differs in the possession of a laterally compressed body and a long six-jointed pleon.

In addition to the description of these underground forms, the writer gives a *résumé* of our only too scanty knowledge of the habits and conditions of life of subterranean animals. He discusses also the question of the origin of cave forms, and arrives at the conclusion that the New Zealand subterranean crustacea have clearly been derived from a surface fauna, though the affinities of one or two species seem to be rather with marine than with known fresh-water forms. It is pointed out, however, that the cave fauna is not necessarily descended from the present surface fauna of the country; *Crangonyx compactus*, for instance, has its nearest allies in Europe and North America, and the remarkable habitat of the fresh-water species of *Phreatoicus* has already been mentioned.

Cave crustaceans, according to Packard, live "in a sphere where there is little, if any, occasion for struggling for existence between these organisms." Chilton, however, suggests that there is evidence for thinking that Natural Selection has come into play in the evolution of cave animals. He points out that the scanty supply of food must inevitably lead to a keen struggle. Moreover, Packard himself states that the *Cæcidotea* and *Crangonyx* of the North American caves are eaten by the blind crayfish, which in its turn is devoured by the blind fish *Amblyopsis;* so that these animals must struggle with their destroyers. To this end have probably been developed the additional olfactory setæ, described by Packard and others, to enable the pursued animals to escape from their enemies. If there were no occasion for struggling for existence, why should these additional sense organs have been developed at all? At first sight, it certainly seems natural to attribute the degeneration of the eyes, observed in underground forms, to disuse; and it is but a further step to assume that these new characters, resulting from disuse and adaptation to new conditions of life, were inherited by successive generations. But Chilton ingeniously remarks that, if the modifications in the eyes of cave animals were the direct inherited effect of the environment, we should expect to find the lines of modification similar in all animals subjected to the same conditions. This, however, is not the case, as Packard's own investigations have shown. The influences leading to degeneration act uniformly on all individuals, but the modifications produced in the eyes are various, and occur in different ways. In some cases there is total atrophy of the optic lobes and optic nerves, with or without the persistence in part of the pigment (or retina) and the crystalline lens; in others the optic lobes and optic nerve persist, but there is total atrophy of the rods and cones, retina, and facets; while in extreme cases there is total atrophy of the optic lobes and nerves, and all the optic elements. These examples, showing a development apparently capricious and varying in direction in animals all subjected to the same or similar environment, point rather to the action of Natural Selection than to that of the direct inherited influence of the conditions of life.

In a more recent essay in the *American Naturalist* (September 1894), Packard has restated his views on the subject of the modifications of the eyes in subterranean animals, and concludes his remarks with the following words: "That while the heredity of acquired characters was, in the beginning, the general rule, as soon as the congenitally blind preponderated, the heredity of congenital characters became the normal state of things." In support of his view, Packard cites some statistics upon the inter-marriage of deaf-mutes, which have been recently furnished by Prof. Graham Bell. It would appear that, in America at any rate, the segregation of deaf-mutes within asylums has been followed by a striking increase in intermarriages among them; so that, of the deaf-mutes who marry at the present time, no less than 80 per cent. marry deaf-mutes. A marked increase in the number of the deaf-mute population has ensued, and

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